

Space Science and the President's Renewed Spirit of Discovery

Presented
to the
Structure & Evolution of the Universe Subcommittee
Origins Subcommittee

February 2004

- After months of White House and NASA interagency meetings, and exchanges of ideas and visions, a new comprehensive exploration vision has been developed
 - Given its importance, final decisions made by President
 - Final decisions preceded successful *Spirit* landing on Mars
- New exploration vision builds on NASA's vision and mission statements
 - Other NASA activities remain an important element of NASA's mission such as aeronautics and climate change research

New Space Exploration Vision

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- On January 14, the President announced a new vision for NASA
 - Implement a sustained and affordable human and robotic program to explore the solar system and beyond;
 - Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations;
 - Develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration; and
 - Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.
- The vision affirms the nation's commitment to space exploration and provides a clear direction for the civil space program
 - Vision responds to concerns expressed by the CAIB, Congress, and elsewhere on the need for a long-term vision for human space exploration
 - Vision broader than some reports that it is about returning humans to Moon. Indeed, robotic activities and exploration of other destinations are critical elements
 - Activities will be paced by experience, technology readiness, and affordability
 - Implementation begins now with key missions that are already in progress such as Mars exploration, visits to other solar system targets, and Origins activities

Guiding Principles for Exploration

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- Pursue Compelling Questions
 - Exploration of the solar system will be guided by compelling questions of scientific and societal importance.
 - Consistent with the NASA Vision and Mission, NASA exploration programs will seek profound answers to questions of our origins, whether life exists beyond Earth, and how we could live on other worlds.
- Across Multiple Worlds
 - NASA will make progress across a broad front of destinations.
 - Consistent with recent discoveries, NASA will focus on likely habitable environments at the planet Mars, the moons of Jupiter, and in other solar systems.
 - Where advantageous, NASA will also make use of destinations like the Moon and near-Earth asteroids to test and demonstrate new exploration capabilities.
- Employ Human and Robotic Capabilities
 - NASA will send human and robotic explorers as partners, leveraging the capabilities of each where most useful.
 - Robotic explorers will visit new worlds first, to obtain scientific data, demonstrate breakthrough technologies, identify space resources, and send tantalizing imagery back to Earth.
 - Human explorers will follow to conduct in-depth research, direct and upgrade advanced robotic explorers, prepare space resources, and demonstrate new exploration capabilities

Guiding Principles for Exploration (cont.)

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- For Sustainable Exploration
 - NASA will pursue breakthrough technologies, investigate planetary resources, and align ongoing programs to develop sustainable, affordable, and flexible solar system exploration strategies.
 - The vision is not about one-time events and, thus, costs will be reduced to maintain the affordability of the vision
- Starting Now
 - NASA will pursue this vision as our highest priority.
 - Consistent with the FY 2005 Budget, NASA will immediately begin to realign programs and organization, demonstrate new technical capabilities, and undertake new robotic precursor missions to the Moon and Mars before the end of the decade.

Key Elements of New Space Policy

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- **Space Shuttle**
 - Return the Space Shuttle to flight and plan to retire it by the end of this decade, following the completion of its role in the construction of the International Space Station
- **International Space Station**
 - Complete assembly,
 - Refocus research to exploration factors affecting astronaut health, and
 - Acquire crew and cargo systems, as necessary, during and after availability of Shuttle.
- **Crew Exploration Vehicle**
 - Develop a CEV to travel beyond low Earth orbit, the first new U.S. human space flight vehicle since the 1980s.
 - Undertake first test flight by the end of this decade in order to provide an operational capability to support human exploration missions no later than 2014.
- **Lunar Exploration**
 - Begin robotic missions to the Moon by 2008, followed by a period of evaluating lunar resources and technologies for exploration.
 - Begin human expeditions to the Moon in the 2015 – 2020 timeframe.



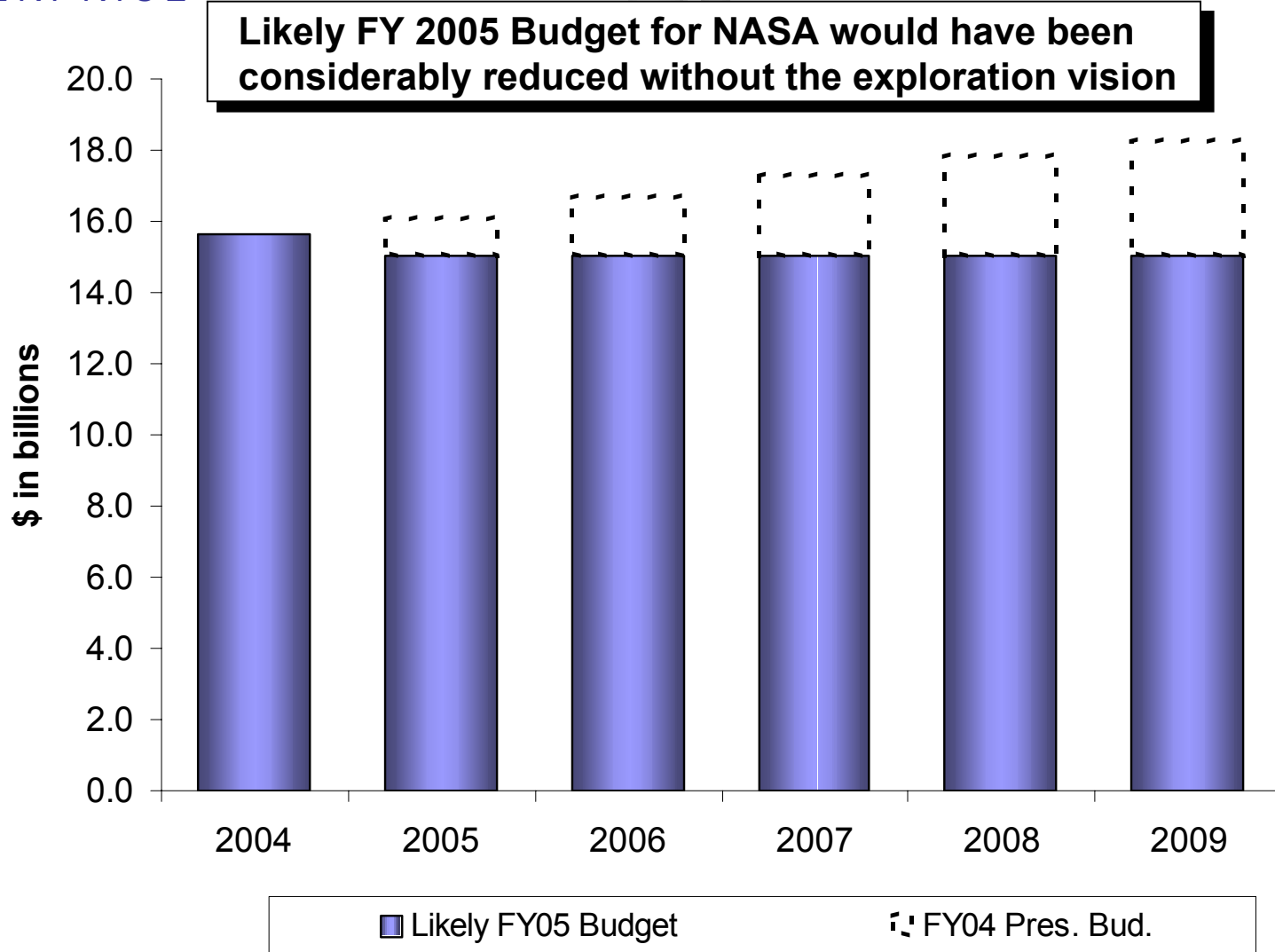
Key Elements of New Space Policy (cont.)

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- Mars Exploration
 - Conduct robotic exploration of Mars to search for evidence of life, to understand the history of the solar system, and to prepare for future human exploration.
 - Timing of human missions to Mars will be based on available budgetary resources, experience and knowledge gained from lunar exploration, discoveries by robotic spacecraft at Mars and other solar system locations, and development of required technologies and know-how.
- Other Solar System Exploration
 - Conduct robotic exploration across the solar system for scientific purposes and to support human exploration.
 - In particular, explore Jupiter's moons, asteroids and other bodies to search for evidence of life, to understand the history of the solar system, and to search for resources;
- Exploration Beyond
 - Conduct advanced telescope searches for Earth-like planets and habitable environments around other stars;
- Enabling Capabilities
 - Develop and demonstrate power generation, propulsion, life support, and other key capabilities required to support more distant, more capable, and/or longer duration human and robotic exploration of Mars and other destinations.

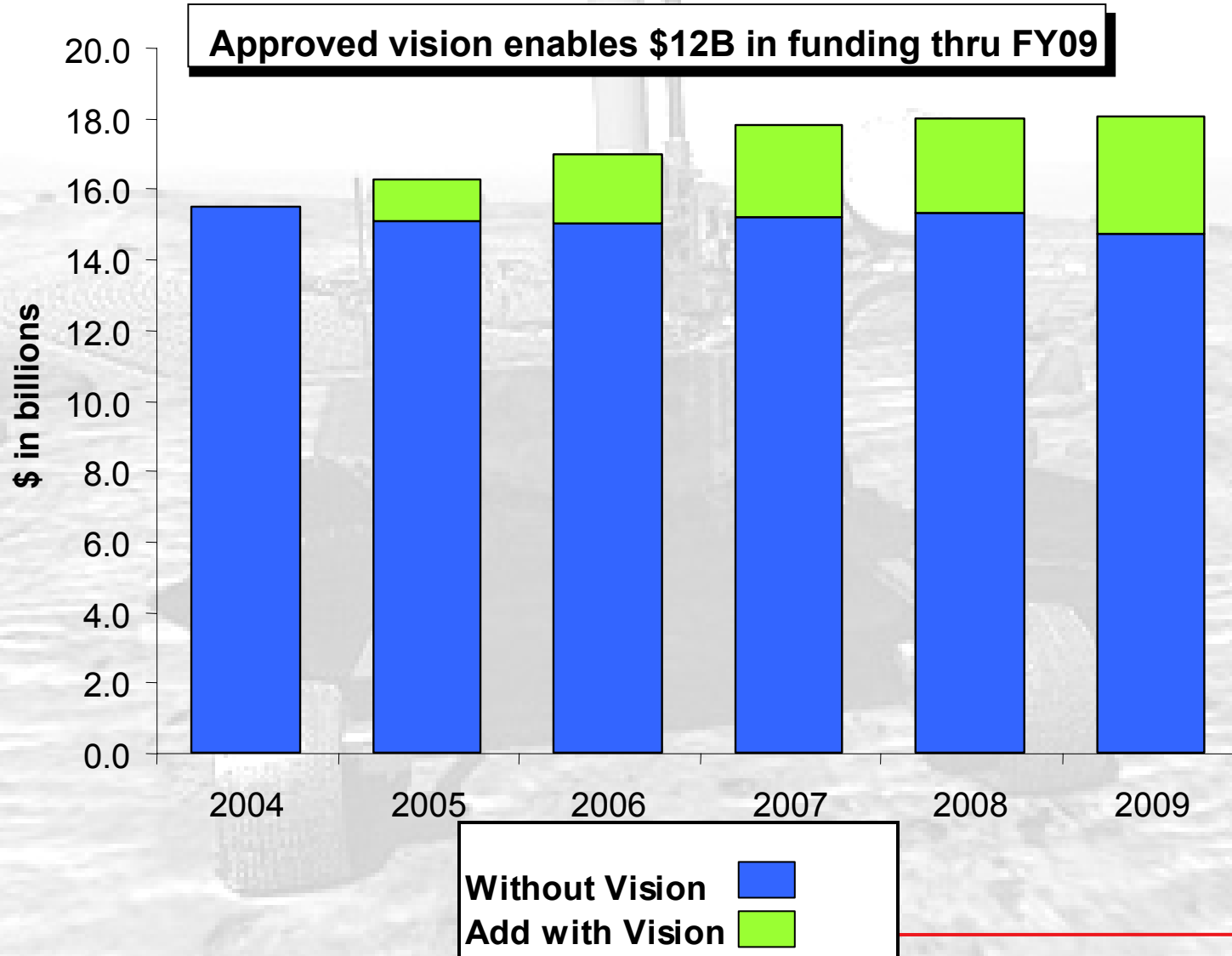
Facing Major Cuts Without the New Vision

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Budget with Approved Exploration Vision

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Budget Strategy for Exploration Vision

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- NASA's new exploration plan is affordable in both the short-term and long-term.
 - Budget will increase by 5% per year over the next three years, and at about 2% (inflation) per year thereafter.
 - NASA annual budget is currently about 0.7 percent of the total Federal budget, with the annual cost per taxpayer equivalent to a month of cable, family trip to a movie, or 15 cents per day.
- NASA will be able to carry out a robust exploration program with provided budget increases.
 - NASA will reallocate resources within its existing budget in three main ways:
 - NASA will realign existing programs as necessary to enable the vision.
 - NASA will retire the Shuttle to free up billions of dollars in the next decade.
 - NASA will focus on tech innovations that reduce the cost of sustained space operations.
 - Shift in funding reflects the priority of the new national vision for human and robotic exploration of the solar system and beyond

Next Steps

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- Presidential Space Commission
 - Commission formed under chairmanship of Peter Aldridge to examine the implementation of the vision.
 - Report due in four months
- Organization
 - NASA will organize as necessary to implement the vision
 - A new enterprise, Office of Exploration Systems, is responsible for R&T and development of human systems for exploration, including robotic precursor missions to the moon
 - Office of Aeronautics formed to maintain focus on aeronautical research
- Budget
 - President's FY 2005 Budget to released on February 2nd
 - Exploration Vision Document released along with FY05 Budget to link vision to our programs
 - FY 2006 Budget will begin to address uncertainties in implementing the vision, for example, refocusing programs, assigning program responsibilities, and addressing institutional issues

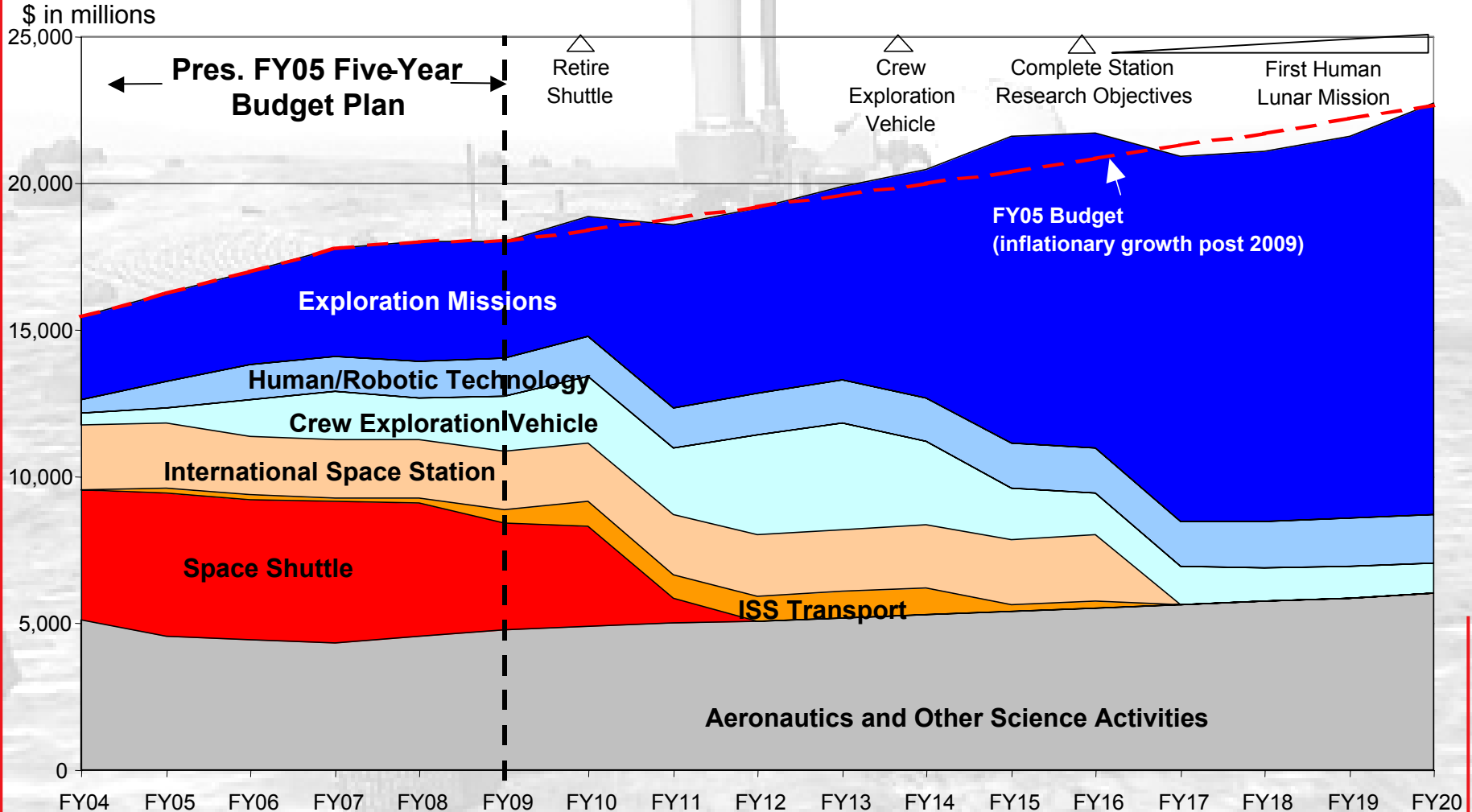
Summary of New Vision

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- **Benefits the Nation**
 - Makes needed decisions to secure long-term US space leadership
 - Encourages innovation and strengthens industrial base
 - Pursues compelling science and inspires the next generation of explorers
- **Refocuses NASA**
 - Establishes exciting long-term vision
 - Integrates robotic and human exploration programs around focused science goals
 - Responds to CAIB Recommendations (Shuttle retirement, new long-term goal)
- **Provides exciting set of major milestones such as:**
 - Implement Vision; Reorganize NASA ~2004
 - Initial Flight Experiments ~2006
 - Crew Exploration Vehicle First Test Flight ~2007-8
 - Start Annual Lunar Robotic Missions ~2008
 - Retire Shuttle and Complete Station Assembly ~2010
 - “Safe on Mars” Lander Mission ~2011
 - Mars Robotic Sample Return ~2013
 - Nuclear In-Space Power/Propulsion Demo ~2015
 - Moon Human Landing/Exploration Testbed ~2015-20

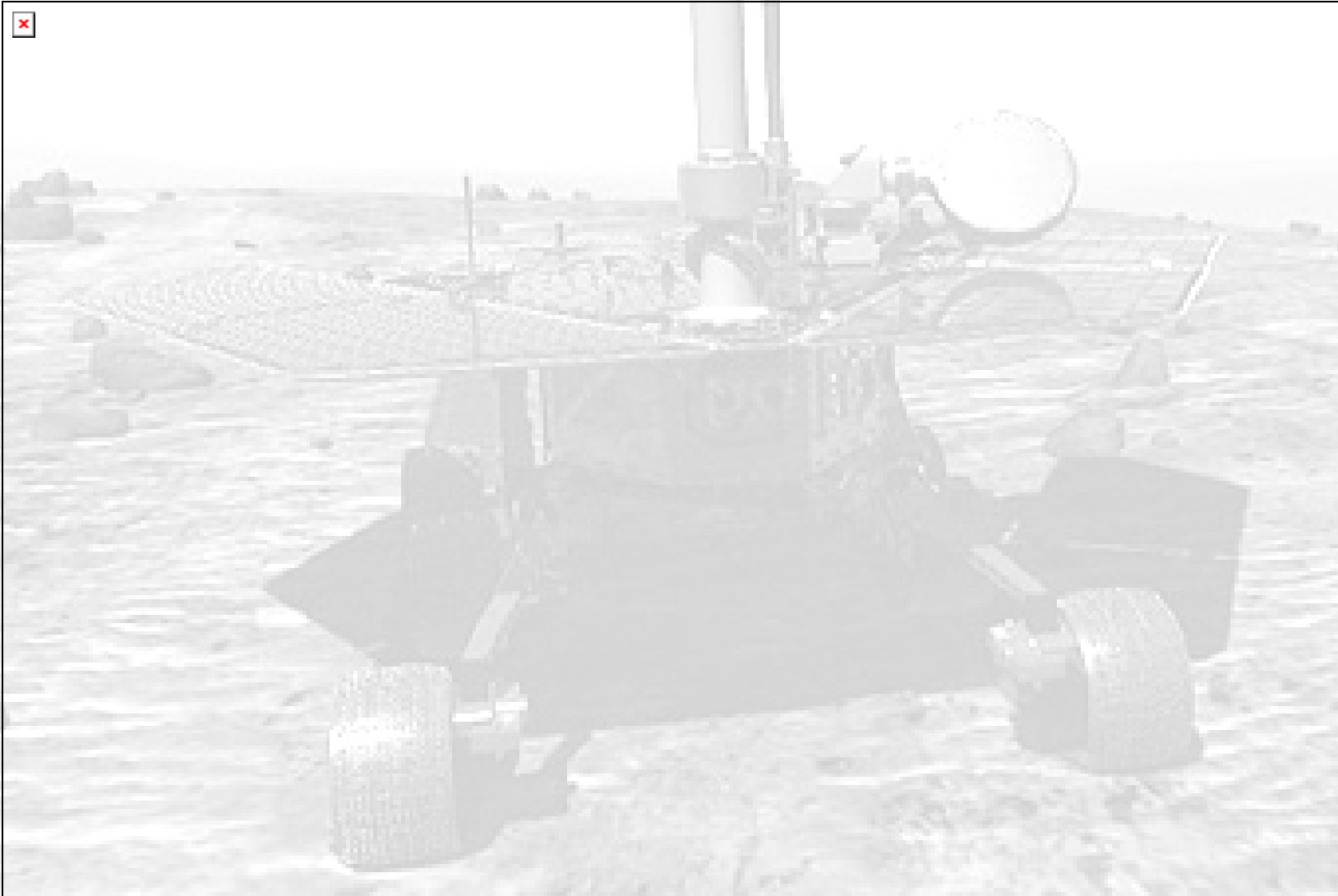
NASA's FY05 President's Budget

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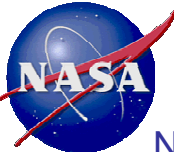
Space Science FY05 President's Budget

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In Aeronautics
and Other Science

In Exploration
Missions

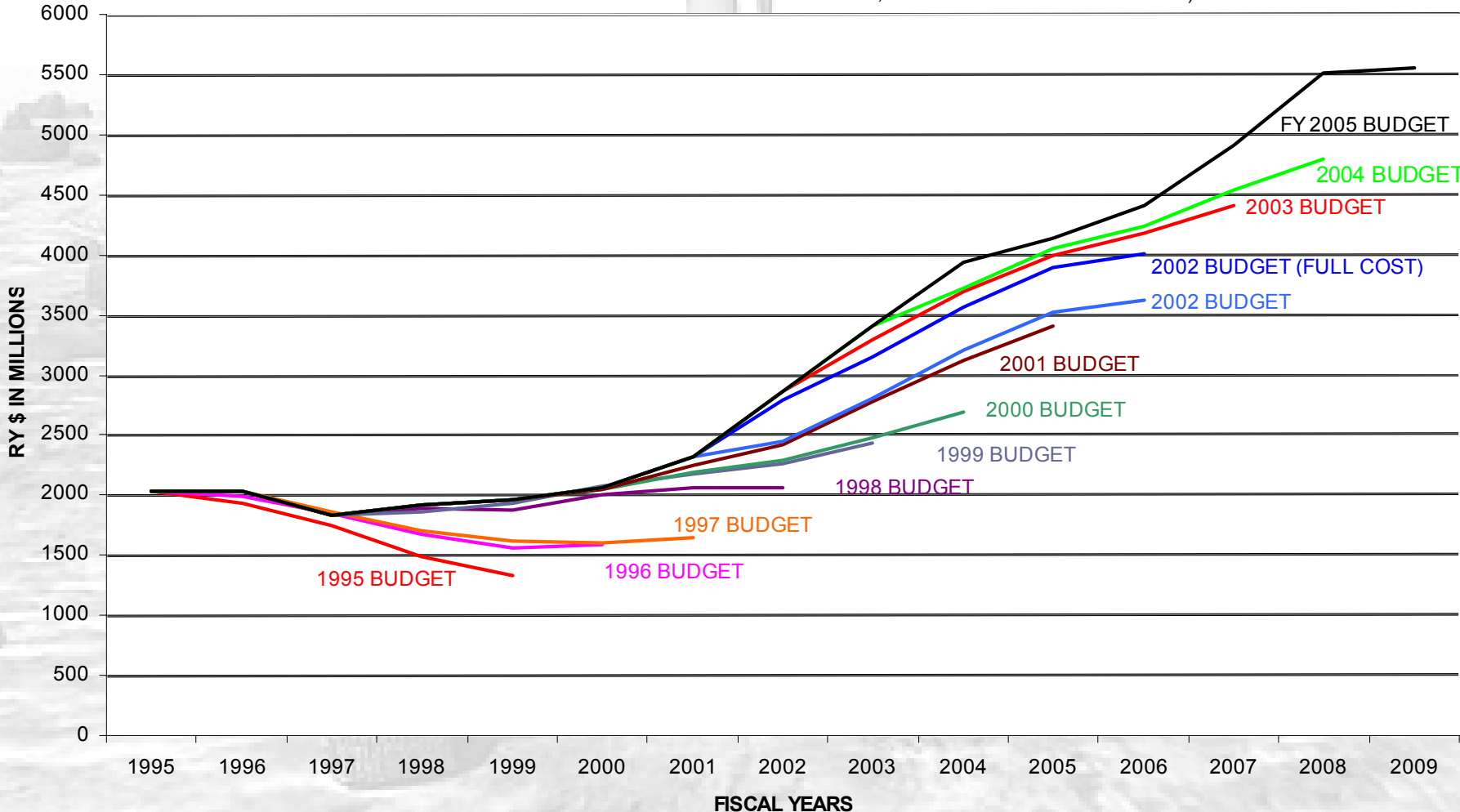


NASA

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SPACE SCIENCE BUDGET HISTORY

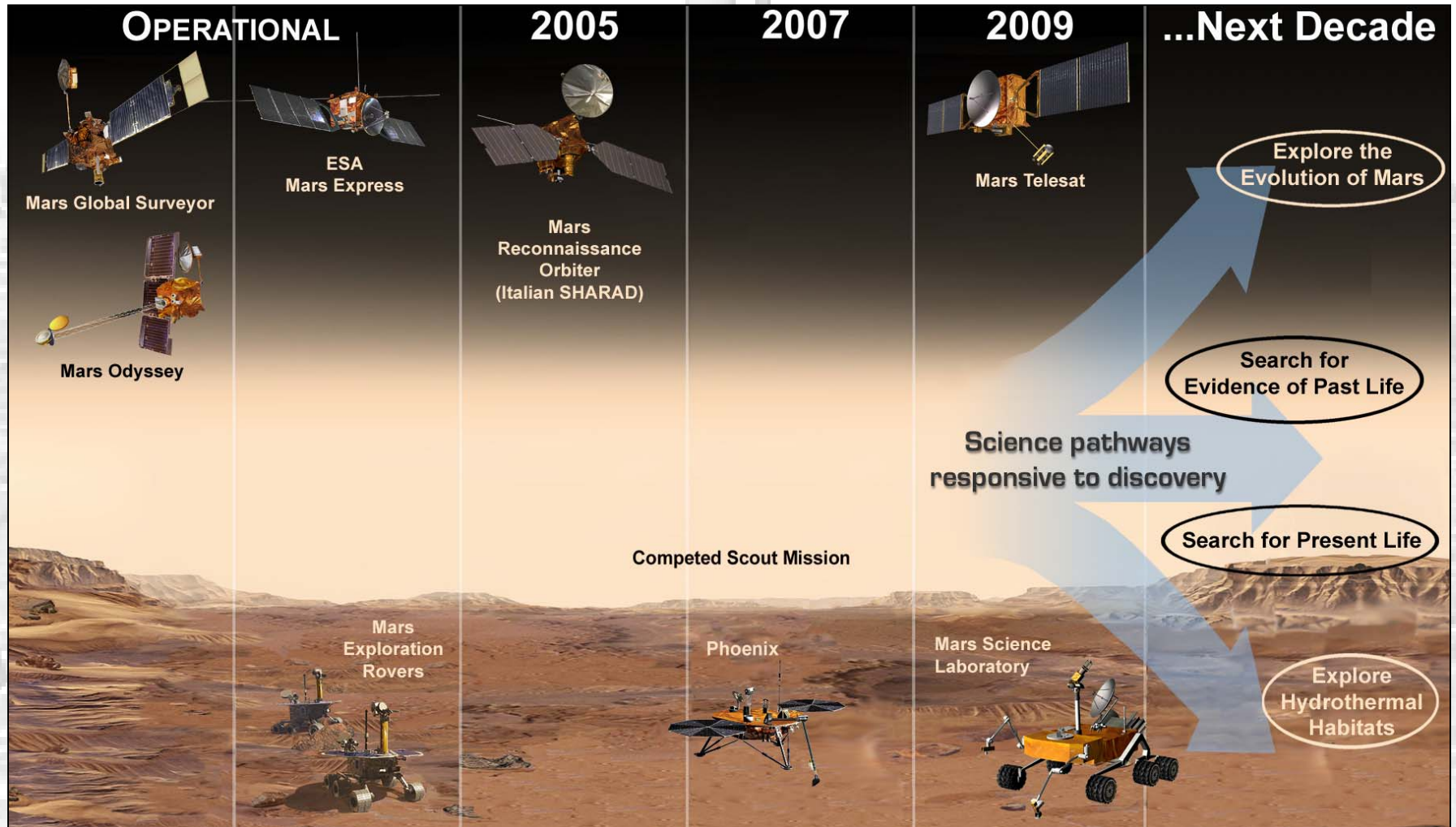
(BUDGET NORMALIZED TO INCLUDE ELV'S IN ALL YEARS AND TO REMOVE CROSS ENTERPRISE TECHNOLOGY AND NSI/PROMETHEUS;
MISSION COMMUNICATION SVCS INCLUDED BEGINNING IN FY02; DSN INCLUDED BEGINNING IN FY03)



Mars Exploration Program

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Launch Year



Lunar Exploration

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“Starting no later than 2008, initiate a series of robotic missions to the Moon to prepare for and support future human exploration activities”
- *President George W. Bush, January 2004*



- Rationale
 - Global access
 - Technology “proving ground”
 - Address relevant skill and capability problems similar to ones on Mars
 - Allows realistic assessment of In-Situ Resource Utilization (ISRU) possibilities
 - Allows for optimization of the human and robotic “skill mix” in achieving exploration-enabled science goals
- Program
 - Series of orbiting and/or landed missions designed to satisfy requirements defined by Exploration Enterprise
 - Program implementation modeled after highly successful Mars Program



NASA

Space Science Enterprise

FY 2005 President's Budget Highlights

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ENTERPRISE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FY 2005 PRESIDENT'S BUDGET

NOA IN RY \$M

	<u>FY 2004</u>	<u>FY 2005</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
TOTAL NASA	15,379	16,244	17,003	17,816	18,001	18,034
<u>EXPLORATION, SCIENCE & AERONAUTICS</u>	<u>7,831</u>	<u>7,760</u>	<u>7,870</u>	<u>8,321</u>	<u>8,900</u>	<u>9,091</u>
SPACE SCIENCE	3,943	4,138	4,404	4,906	5,520	5,561
EARTH SCIENCE	1,526	1,485	1,390	1,368	1,343	1,474
BIOLOGICAL & PHYSICAL RESEARCH	965	1,049	950	938	941	944
AERONAUTICS	946	919	957	938	926	942
EDUCATION	164	169	169	171	170	170
EARMARKS	287					
<u>EXPLORATION CAPABILITIES</u>	<u>7,521</u>	<u>8,456</u>	<u>9,104</u>	<u>9,465</u>	<u>9,070</u>	<u>8,911</u>
EXPLORATION SYSTEMS	1,563	1,782	2,579	2,941	2,809	3,313
SPACE FLIGHT	5,857	6,674	6,525	6,524	6,261	5,598
EARMARKS	101					
<u>INSPECTOR GENERAL</u>	<u>27</u>	<u>28</u>	<u>29</u>	<u>30</u>	<u>31</u>	<u>32</u>



FY 2005 President's Budget Highlights

Space Science's Role in the Exploration Initiative

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- New theme has been added: Lunar Exploration
- Space Science themes included in Exploration:
 - Astronomical Search for Origins
 - Solar System Exploration
 - Mars Exploration
 - Lunar Exploration
- Sun-Earth Connections and Structure and Evolution of the Universe have been reduced as priorities have been re-focused



FY 2005 President's Budget Highlights

Major Changes: Solar System Exploration

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- Most elements of Project Prometheus are transferred to the Office of Exploration (Code T)
 - RPS/RTG work retained in OSS
- JIMO fundamental science and instrument technology development/risk reduction retained in OSS
- No funding identified at this time for post-phase A instrument development



FY 2005 President's Budget Highlights

Major Changes: Mars Exploration Program

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- MEP significantly augmented
- Funds added to support next decade of Mars Exploration
 - Additional Mars Scout in 2011
 - Mars Testbed Lander in 2011
 - "Safe on Mars"
 - In-situ resource utilization
 - Technology for post-2010 Mars science pathways
 - Sample return as early as 2013
 - Technology for post-2013 Mars testbeds



FY 2005 President's Budget Highlights

Major Changes: Lunar Exploration

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- A new theme that is an element of the new Agency vision
- Supports robotic exploration of the Moon as precursors to human missions
 - 2008 Lunar Robotic Recon Orbiter
 - 2009 Lunar Robotic Lander
 - Future Lunar Robotic Testbeds
- Managed in OSS's Solar System Exploration division
- Funding begins in FY 05 (70M); \$1.3B through FY 09



FY 2005 President's Budget Highlights

Major Changes: Astronomical Search for Origins

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- HST SM-4 cancelled due to safety and overall risk considerations
 - Examine ways to extend operational life without additional servicing
 - De-orbit via an autonomous rendezvous mission
- JWST funding profile shifted forward for schedule recovery/assurance



FY 2005 President's Budget Highlights

Major Changes: Structure and Evolution of the Universe

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- LISA delayed one year
- CON-X delayed two years
- Einstein Probes deferred beyond the current budget horizon
- Some additional funding provided to GP-B, GLAST, and SWIFT



FY 2005 President's Budget Highlights

Major Changes: Sun-Earth Connections

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- Solar Terrestrial Probes significantly reduced and stretched out
- SEC R&A/Operations (non-LWS) frozen at FY 04 Level
- LWS fully funded
- Future MDEX Explorers delayed two years
 - May consider making fewer SMEX selections and delaying MDEX AO only one year

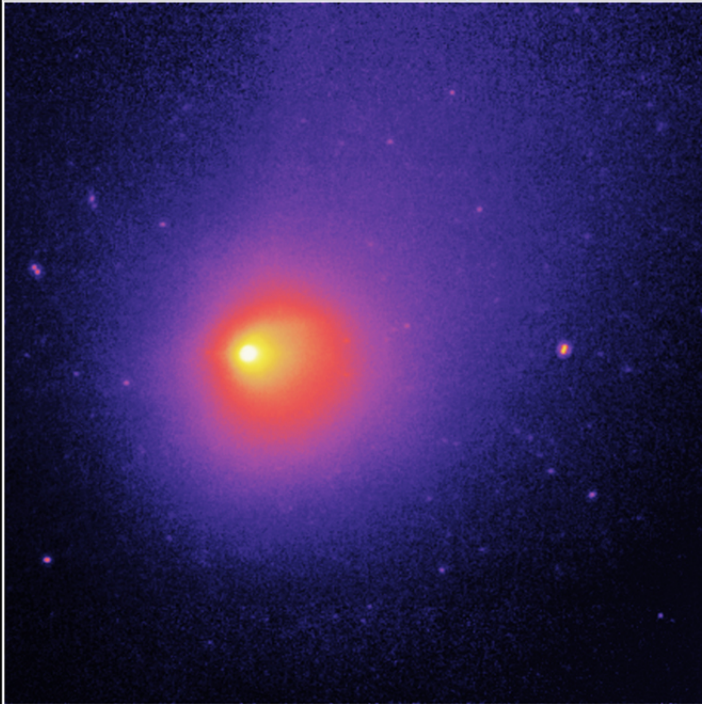
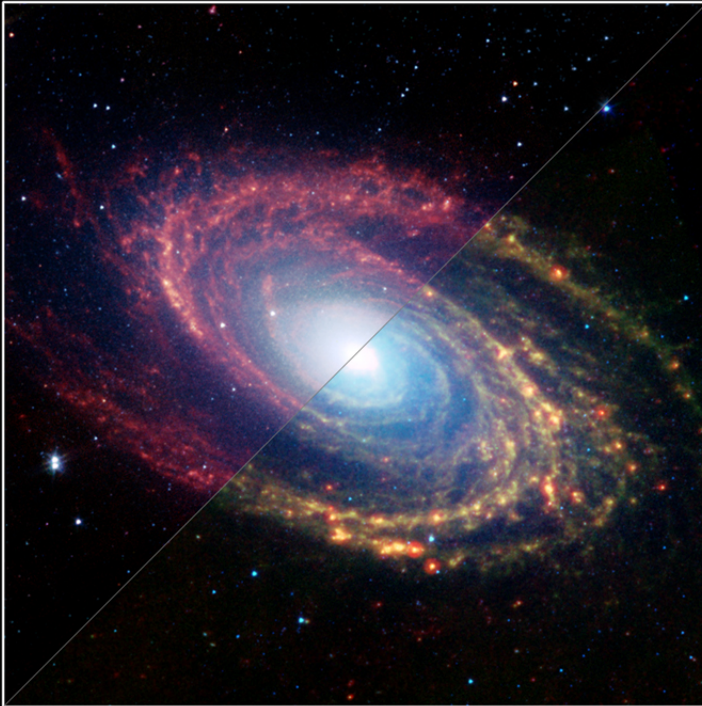


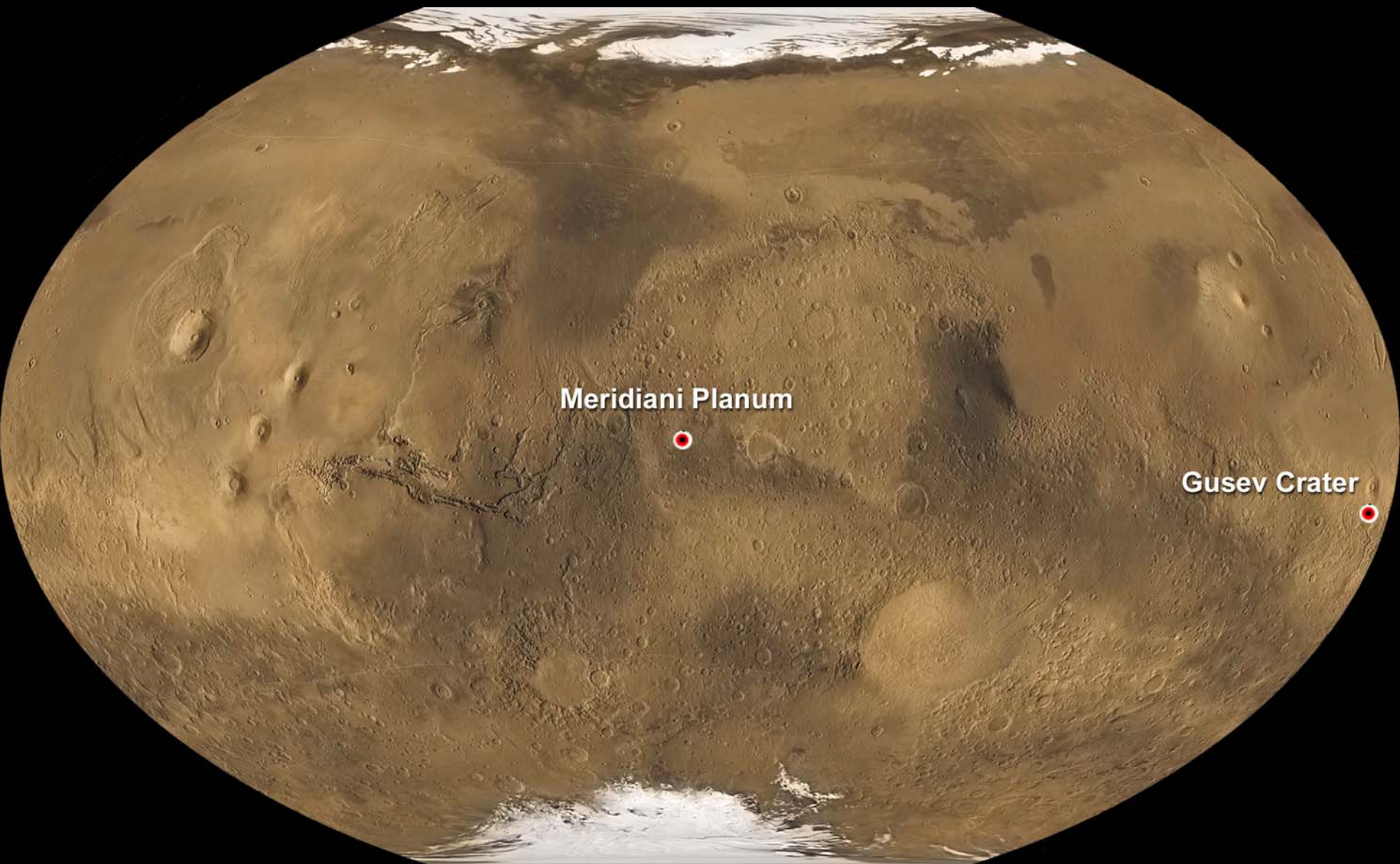
FY 2005 President's Budget Highlights

Major Changes: Facilities

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- Start of JPL Flight Projects Center deferred until FY06
- Start of GSFC Space Science Building deferred until FY 06





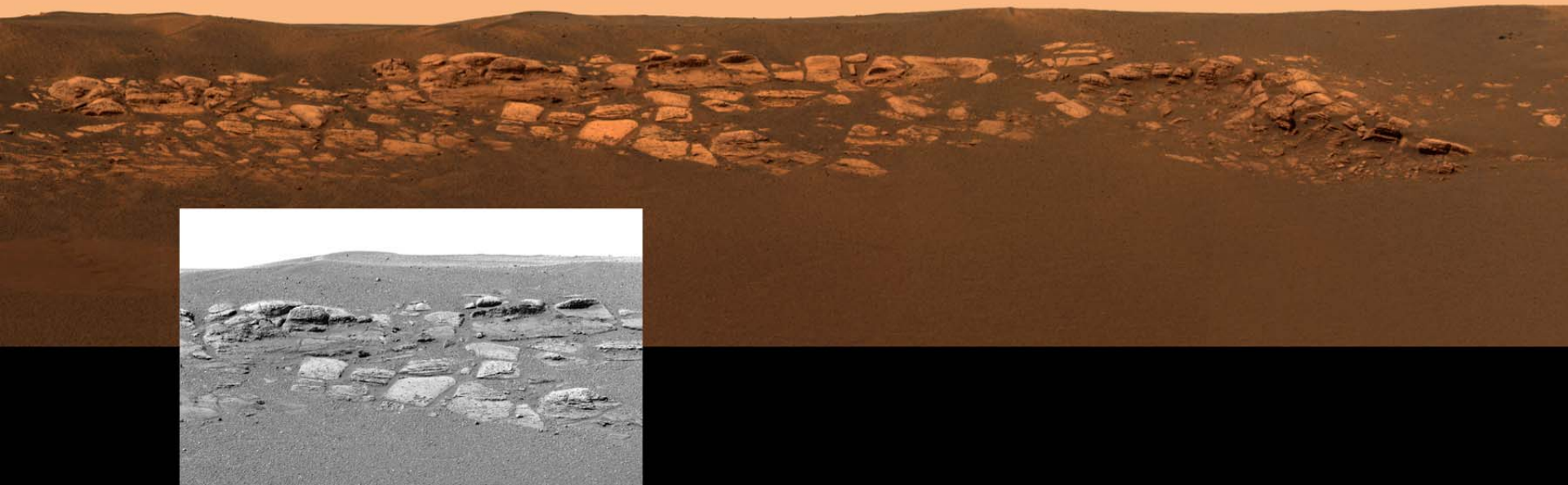
Meridiani Planum

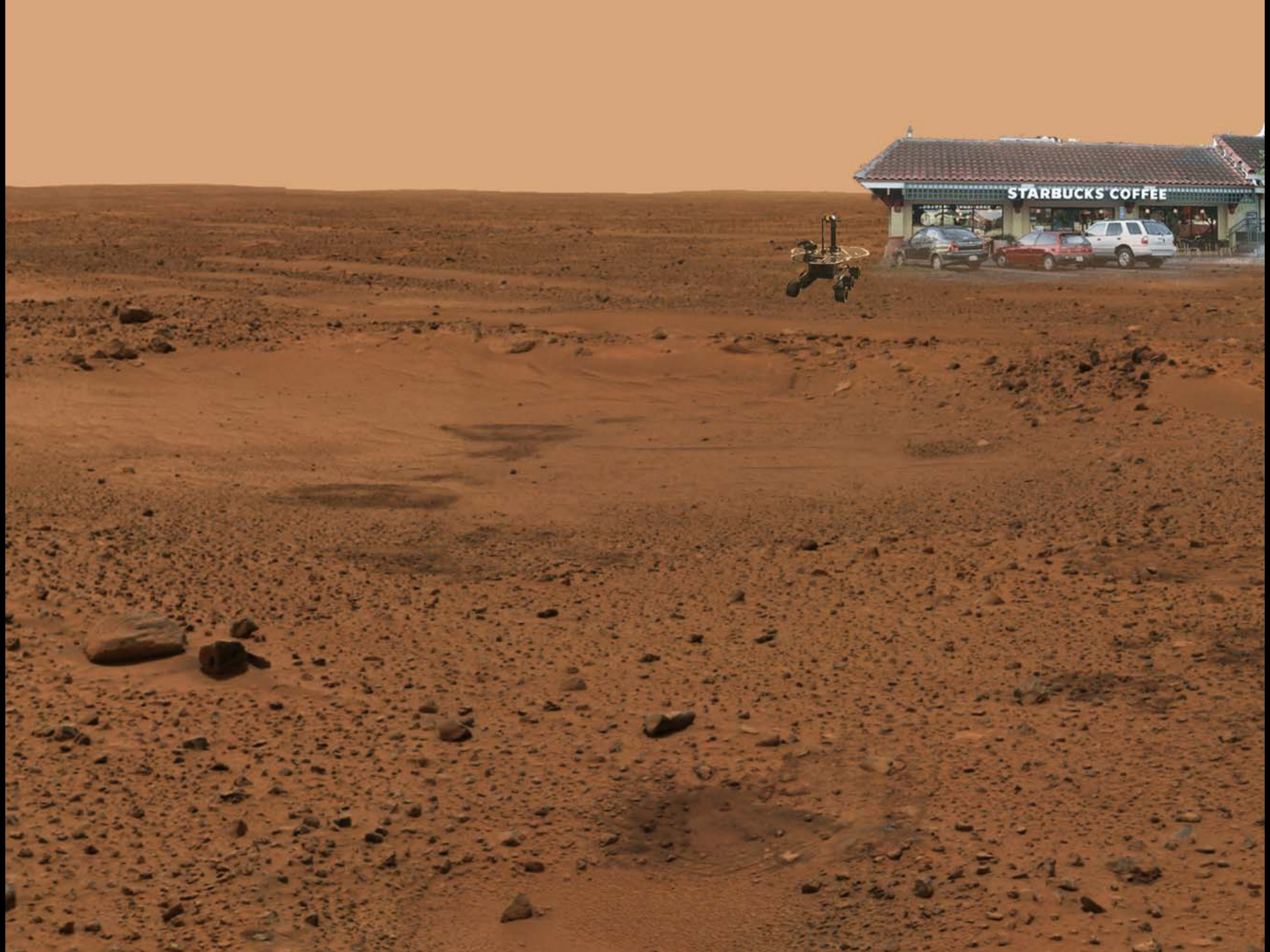
Gusev Crater

Spirit view of the East Hill Complex at Gusev Crater



Opportunity view of layered rock outcrop at Meridiani Planum

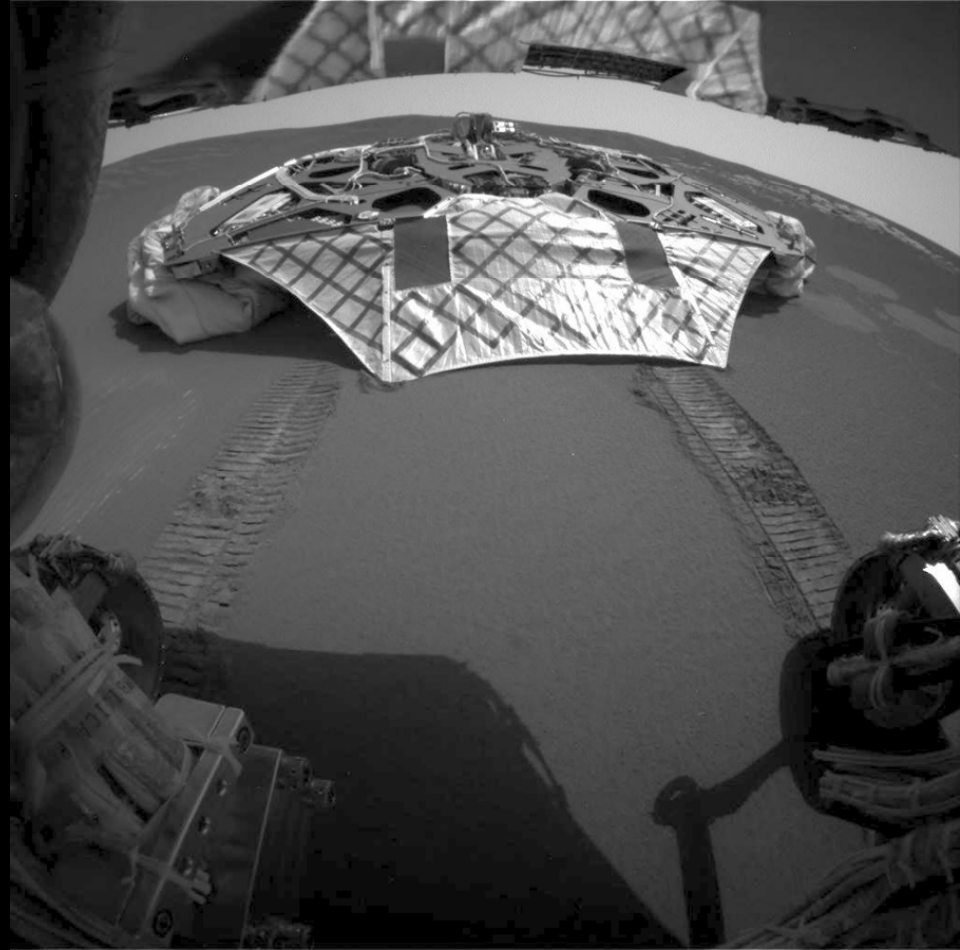




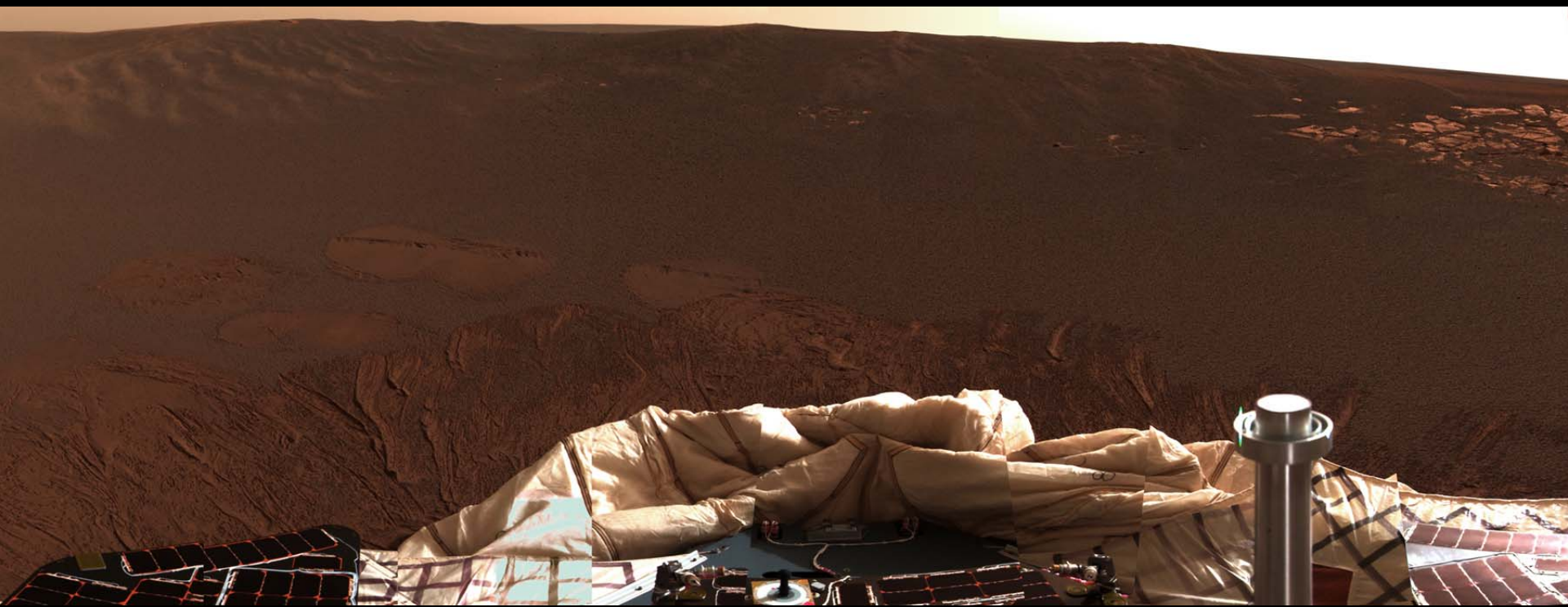
Spirit at Gusev Crater



Opportunity at Meridiani Planum



12 wheels in the dirt!



“Hole in One” — *Opportunity* within crater at Meridiani Planum

